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[Superseding IS : 2934 (Part I) - 1964]
(Reaffirmed 2002)

Indian Standard

SPECIFICATION FOR VARIABLE RESISTORS

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

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Indian Standard

SPECIFICATION FOR VARIABLE RESISTORS

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 28 September 1977, after the draft finalized by the Capacitors and Resistors for Electronic Equipment Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard (Part I) covers general requirements and test methods for all types of variable resistors used in the electronic and telecommunication equipment. The object of this standard is to establish uniform requirements and methods of tests for judging the electrical, mechanical and climatic properties of variable resistors.

0.2.1 Methods of tests and general requirements for non-wire wound variable resistors were covered in IS : 2934 (Part I)-1964*. With the publication of this comprehensive standard IS : 2934 (Part I)-1964* is withdrawn.

0.2.2 The specific requirements and tests for particular types of variable resistors shall be covered in the relevant specification.

0.2.3 Necessary references have been made in this standard to IS : 589-1961† in which details of the various climatic and mechanical durability tests have been covered. The applicable degree of severity, special conditions and performance figures in relevant cases only have been included in this standard.

0.3 The general requirements and methods of tests described in this standard relate to the widely used single-turn rotary variable resistors with a control spindle. For other types of variable resistors covered in this standard:

a) the angle of rotation may be several turns,

*Specification for non-wire-wound variable resistors (potentiometers), Type 2 : Part I Tests and general requirements.

†Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

b) the reference to control spindle shall apply to any other adjusting device,

c) the total mechanical rotation and the angle of effective rotation shall be taken to mean the mechanical travel and the effective travel of the adjusting device, and

d) a value for force shall be prescribed instead a value for torque if the actuating device moves in a linear instead of a rotary manner.

0.4 For variable resistors where the movement of the moving contact is other than rotary, the relevant specification shall re-define the appropriate terms and definitions and spell out the individual requirements and the corresponding methods of tests, if required.

0.5 While preparing this standard, assistance has been derived from:

IEC Publication 393-1 (1973) Potentiometers: Part I Terms and methods. International Electrotechnical Commission.

JSS : 50500-1971 General requirements for resistors, variable. Directorate of Standardization, Department of Defence Production, Ministry of Defence, New Delhi.

0.6 This standard is one of a series of Indian Standards relating to resistors used in electronic and telecommunication equipment. A list of standards published so far in the series is given on fourth cover page.

0.7 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) covers the general requirements and methods of tests for all types of variable resistors of power dissipation up to and including 16W, including lead screw actuated type, presets, multi-turn units, etc, to be used in electronic and telecommunication equipment.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Category Temperature Range — The range of ambient temperatures over which the component has been designed to operate continuously; this is defined by the appropriate category.

2.2 Upper Category Temperature — The maximum ambient temperature for which a variable resistor has been designed to operate continuously at the category dissipation.

*Rules for rounding off numerical values (*revised*).

2.3 Lower Category Temperature — The minimum ambient temperature for which the component has been designed to operate continuously.

2.4 Variable Resistor, Precision — A mechanically variable resistor of a type suitable for application in circuits where high stability of the resistance value, an exactly defined resistance law and close tolerance are essential. The dissipation is generally not of major importance.

2.5 Variable Resistor, General Purpose — A mechanically variable resistor of a type suitable for application in circuits where stability of the resistance value, tolerance on resistance law and tolerance on resistance value are generally not of major importance. In certain types, power dissipations facilities may be essential.

2.6 Variable Resistors, Preset — Variable resistor of precision or general purpose type which is designed for relatively infrequent adjustments.

NOTE — Typical examples of preset variable resistors are single turn rotary variable resistors with screwdriver slot lead screw actuated devices, etc.

2.7 Direction of Rotation — Rotation is defined as clockwise or counter-clockwise when viewing the face of the variable resistor which includes the means of actuation.

2.8 Resistance Law — The relationship of the resistance value between the terminations *a* and *b* (or of the output ratio usually expressed in percentage) to the mechanical position of the moving contact.

2.8.1 Variable resistor laws are classified as follows:

a) Linear Law — Law A (*see* Fig. 1A),

b) Logarithmic Law — Law B (*see* Fig. 1B), and

c) Reversed Logarithmic Law — Law C (*see* Fig. 1C).

NOTE — Laws other than the widely used laws A, B and C (for example, sine or cosine) may be required for special applications. The law will then be defined in the relevant specification.

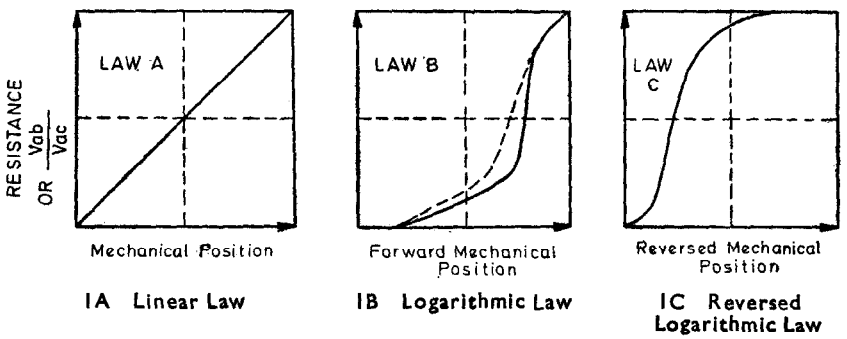


FIG. 1 COMMON VARIABLE RESISTOR LAWS

2.9 Rated Resistance — The resistance value marked upon the variable resistor.

2.10 Critical Resistance — That resistance above which the rated voltage may not be applied to a variable resistor.

2.11 Rated Dissipation — The maximum allowable dissipation between terminations *a* and *c* of a variable resistor at an ambient temperature of 70°C unless otherwise specified, under conditions of the electrical endurance test at 70°C which will result in a change in resistance not greater than that specified for that test.

NOTE — In practice, the dissipation is modified by the following conditions.

a) For high values of resistance, the limiting element voltage may prevent the rated dissipation being attained.

b) For the dissipation at temperatures other than 70°C, reference should be made to the derating curve, given in the relevant specifications.

c) When only a portion of the resistance element is engaged, rated dissipation is reduced in approximately the same proportion as the resistance.

2.12 Category Dissipation — That fraction of the rated dissipation applicable at the upper category temperature taking account of the derating curve in the relevant specification.

NOTE — For some types of variable resistors, the category dissipation is zero.

2.13 Rated Voltage — The dc or ac rms voltage calculated from the square root of the product of the rated resistance and the rated dissipation.

NOTE — At high values of resistance, the rated voltage may not be applicable because of the size and construction of the variable resistor.

2.14 Limiting Element Voltage — The maximum dc or ac rms voltage which may be applied across the element of a variable resistor.

2.15 End Voltage — The minimum voltage that exists between the contact arm and the corresponding end termination, when the contact arm is positioned at the extreme counter clockwise or clockwise termination.

2.16 Terminal Resistance — The minimum resistance which may be obtained between the end termination *a* or *c* and the termination of the moving contact *b*.

NOTE 1 — The lowest resistance value need not correspond with the mechanical end stops.

NOTE 2 — Where there is no sharp change of resistance between the end stop and the point where the minimum effective resistance is observed, the terminal resistance and the minimum effective resistance become the same.

2.17 Total Mechanical Rotation — The full extent of the travel of the actuating device between the end stops.

NOTE 1 — In variable resistors fitted with a slipping clutch, the position of the end stops shall be defined as those points where the clutch starts to slip at each end of the travel of the moving contact.

NOTE 2 — For slider type of variable resistors, the term total *mechanical travel* is used.

2.18 Angle of Effective Rotation — The angle throughout which the resistance changes in the manner prescribed by the declared resistance law (*see* Fig. 2).

2.19 Angle of Ineffective Rotation — The angle over which the declared resistance law is not applicable (*see* Fig. 2).

NOTE — For slider type of variable resistors, the term *ineffective travel* is used.

2.20 Minimum Effective Resistance — The resistance value at each end of the effective rotation between termination *b* and the nearest end termination *a* or *c* (*see* Fig. 2).

2.21 Effective Resistance — That portion of the total resistance over which the resistance changes in the manner prescribed by the declared resistance law. It is the total resistance less the sum of the two minimum effective resistances.

2.22 Conformity — The maximum deviation of the actual from the theoretical resistance law, when these are expressed as percentages of the effective resistance (*see* Fig. 3).

NOTE — Conformity may be expressed in terms of voltage ratios.

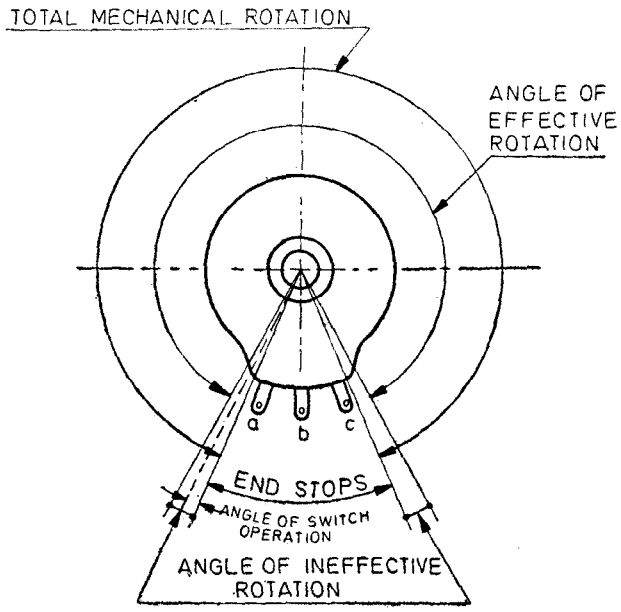


FIG. 2 EXAMPLE OF AN APPLICATION OF THE DEFINITIONS TO SINGLE TURN VARIABLE RESISTOR (SPINDLE END VIEW)

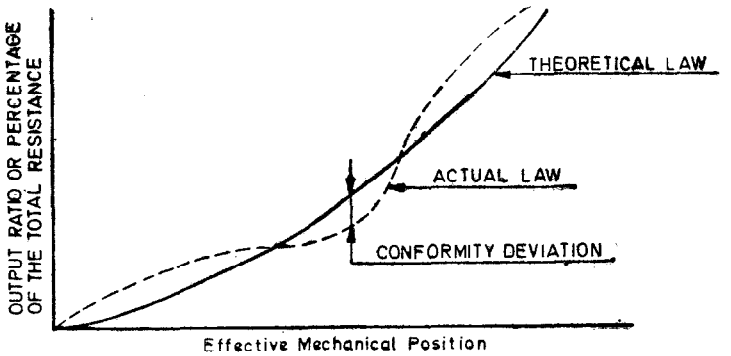


FIG. 3 CONFORMITY

2.23 Linearity — A specific type of conformity where the theoretical law or the resistance ratio is shown as a straight line.

2.24 Resolution — A measure of the sensitivity to which the output ratio or percentage of total resistance of the variable resistor may be set.

2.24.1 *Theoretical Resolution* — The reciprocal of the number of turns of the resistance winding in the actual electrical travel and is expressed as a percentage.

NOTE — This term is normally used in the description of wirewound variable resistors.

2.25 Taps — A fixed electrical connection other than *a* and *c* (*see* **6.2**), made to the resistance element.

2.26 Effective Tap Width — The travel of the spindle, during which the voltage at the terminal *b* and the tap terminal are essentially the same, as the moving contact is moved past the tap in one direction (*see* Fig. 4).

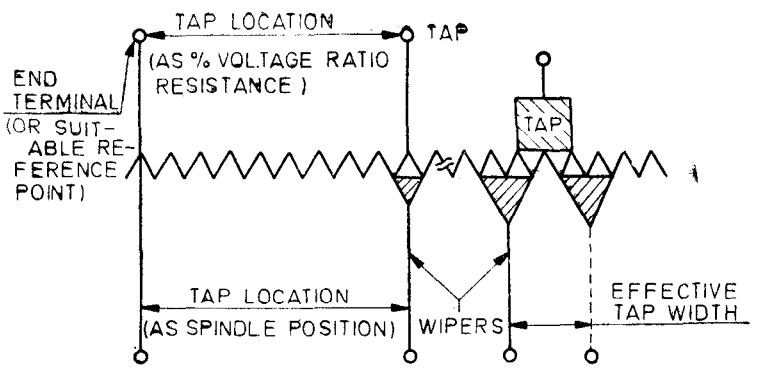


FIG. 4 EFFECTIVE TAP WIDTH

2.27 Tap Location — The position of a tap relative to some reference. This is commonly expressed in terms of resistance, voltage ratio, or spindle position. When a spindle position is specified, the tap position is the centre of the effective tap width.

2.28 Lateral Run Out — The perpendicularity of the mounting surface with respect to the rotational axis of the spindle expressed in millimetres and measured on the mounting surface at a specified distance from the outside edge of the mounting surface when the spindle is held and the body of the variable resistor is rotated while specified loads are applied radially and axially to the body of the resistor.

2.29 Spindle Run Out — The eccentricity of the spindle diameter with respect to the rotational axis of the spindle, expressed in millimetres and measured at a specified distance from the end of the spindle when the body of the variable resistor is held and the spindle rotated while a specified load is applied radially to the spindle.

2.30 Pilot Surface Run Out — The eccentricity of the pilot diameter with respect to the rotational axis of the spindle, expressed in millimetres, and measured on the pilot diameter when the spindle is held and the body of the variable resistor is rotated while a specified load is applied radially to the body of the resistor.

2.31 Spindle End Play — The total axial excursion of the spindle, expressed in millimetre and measured at the end of the spindle with a specified axial load applied alternately in opposite directions.

2.32 Spindle Side Play — The total radial excursion of the spindle, expressed in millimetre and measured at a specified distance from the pilot surface of the unit, with a specified radial load applied alternately in opposite directions at a specified point.

2.33 Operating Torque — The maximum moment in the clockwise and counter-clockwise direction required to initiate spindle rotation anywhere in the total mechanical rotation region.

2.34 Running Torque — The maximum moment in the clockwise and counter-clockwise direction required to sustain uniform spindle rotation at a specified speed throughout the total mechanical rotation region.

2.35 Mechanical Backlash — The maximum difference in the spindle position that occurs when the spindle is moved to the same actual output ratio point from opposite directions. This measurement excludes the effects of resolution and contact width (*see* Fig. 5).

2.36 Pilot Diameter — Diameter of the circular hub of the rim concentric with the shaft of the variable resistor and which helps in accurate positioning of the variable resistor in the panel mounting hole.

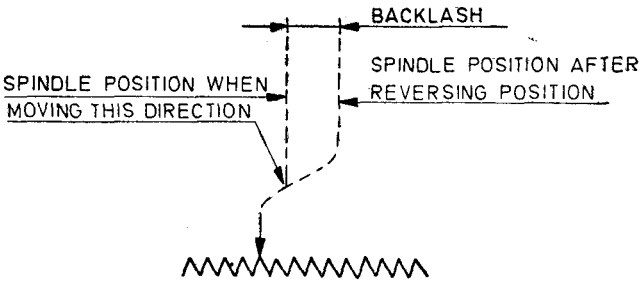


FIG. 5 MECHANICAL BACKLASH

2.37 End Stop Torque — The maximum static torque which can be applied without causing any damage to the spindle or stopping mechanism with the contact sets against the stop.

2.38 Switch Torque — The torque necessary to operate the switch.

2.39 Locking Torque — The maximum torque that can be applied to the spindle without slip.

2.40 Variable Resistors (with a Panel Seal, Spindle Seal or Both) — Variable resistors in which a spindle seal and/or a panel seal are provided to prevent particles and fluid from entering any equipment in which they are mounted.

2.41 Variable Resistor (Container Sealed) — A variable resistor in which the spindle bearing and the container housing of the variable resistor itself are gas tight.

2.42 Type — A type comprises products having similar design features manufactured by the same techniques and falling within the manufacturer's usual range of ratings for these products.

NOTE 1 — Mounting accessories are ignored, provided they have no significant effect on the test results.

NOTE 2 — Ratings cover the combination of:

a) electrical ratings,

b) sizes, and

c) environmental category.

NOTE 3 — The limits of the range of the ratings shall be as specified in the relevant specification.

2.43 Type Tests — Tests carried out to prove conformity with the requirements of this standard. These are intended to check the general quality and design of a given type of variable resistor.

2.44 Acceptance Tests — Tests carried out on samples selected from a lot for the purpose of acceptance of the lot.

2.44.1 *Lot* — All variable resistors of the same category and rating, manufactured by the same factory and during the same period.

2.45 Routine Tests — Tests carried out on each variable resistor to check the requirements which are likely to vary during production.

3. CLIMATIC CATEGORIES

3.1 The climate categories shall be as specified in the relevant specification.

4. RATINGS

4.1 The ratings shall be as stated in the relevant specification.

5. MATERIAL, CONSTRUCTION AND WORKMANSHIP

5.1 Material — Variable resistors shall be constructed from the most suitable materials which shall be free from flaws. All materials used in the construction of the variable resistors shall be such as are not susceptible to any mutual chemical reaction over the entire range of temperature in which the variable resistor is designed to operate.

5.1.1 Materials used shall not support combustion.

5.2 Construction

5.2.1 The variable resistor shall be free from cracks, holes, chips or malformations.

5.2.2 Electrical connections shall be mechanically secure and electrically continuous both before and after soldering.

5.2.3 The variable resistors shall be manufactured and processed in a careful and workmanship like manner in accordance with good design and sound engineering practice.

6. MARKING AND DESIGNATION OF TERMINATIONS

6.1 Each resistor shall be clearly and indelibly marked with the following information:

a) Rated resistance and tolerance;

b) Resistance law;

c) Power rating at 70°C unless otherwise specified;

d) Current and voltage rating for switch (wherever applicable);

e) Manufacturer's name or trade-mark;

f) Type designation;

g) Date of manufacture (in code form in accordance with IS : 8186-1976*); and

h) Any other marking as specified in the relevant detail specification.

6.1.1 Reference face may be marked in accordance with the relevant specification (*see* **2.7**).

6.1.2 The variable resistors may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

6.2 Designation of Terminations — The three terminations of the variable resistor shall be designated as follows :

a — end termination electrically nearest to the moving contact with the spindle set fully anticlockwise as defined in **2.7**,

NOTE — In case of slider type of variable resistors, the spindle shall be set fully at the extreme end of the start.

b — termination of the moving contact; and

c — other end termination.

NOTE 1 — The numbers 1, 2 and 3 or colours yellow, red and green may be used as alternatives to *a*, *b* and *c* respectively. Additional letters, or numbers, for other terminations shall be allocated in the relevant specification.

NOTE 2 — For taps, wherever they appear, the letter shall be '*d*' or '4' nearest to the terminal '*a*' or '1'.

7. GENERAL CONDITIONS FOR TESTS

7.1 Selection of Samples — The samples for test shall be so selected as to be representative of the range of resistance value, wattage rating, temperature classification and category of the variable resistor under consideration.

*Marking codes for values and tolerances of resistors and capacitors [*superseding* IS : 825-1956 and IS : 4114-1967].

7.2 Atmospheric Conditions for Tests — Unless otherwise specified, the tests shall be carried out under standard atmospheric conditions for testing as specified in IS : 589-1961*.

7.3 Preconditioning — Before measurements are made the variable resistors shall be stored at the measuring temperature and relative humidity for sufficient time to allow the entire variable resistors to reach these conditions. The recovery period allowed for, after climatic conditioning is normally adequate for this purpose.

7.4 Corrections to be Applied — When measurements are made at a temperature other than the reference temperature, the results shall, wherever necessary, be corrected to the reference temperature. The ambient temperature during the test shall be stated in the report.

7.5 Drying — When drying is called for in this standard, the variable resistor shall be conditioned before measurement is made using Procedure I or Procedure II as prescribed in the relevant specification.

Procedure I : For 24 $\pm$ 4 hours in an oven at a temperature of 55 $\pm$ 2°C and at a relative humidity not exceeding 20 percent.

Procedure II : For 96 $\pm$ 4 hours in an oven at 100 $\pm$ 5°C.

7.5.1 The variable resistor shall then be allowed to cool in a desiccator using a suitable desiccant, such as activated alumina or silica gel, and shall be kept therein from the time of removal from the oven to the beginning of the specified test.

8. ELECTRICAL TESTS

8.1 Electrical Continuity

8.1.1 The variable resistor shall be loaded in such a way that none of its ratings is exceeded throughout the measurement. The resistance variation between terminations *a* and *b* is observed whilst the spindle or lead screw is operated steadily in each direction at a rate specified in the relevant specification.

8.1.2 The resistance variation between terminations *a* and *b* shall be reasonably smooth over the resistance element when the actuating device is operated slowly.

8.1.3 Unless otherwise specified, there shall be no electrical discontinuity when the moving contact is moved over the total mechanical rotation.

8.1.4 There shall be no electrical discontinuity when the clutch is acting at each end of the travel of the moving contact of variable resistor fitted with slipping clutches.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

8.2 Element (Total) Resistance

8.2.1 The resistance shall be measured using a direct voltage of small magnitude applied for as short a time as practicable, in order that the temperature of the resistance element will not rise appreciably during measurement.

In the event of conflicting results, attributable to such test voltages, the voltage specified in Table 1 shall be used for referee purposes, unless otherwise specified in the relevant specification.

TABLE 1 TEST VOLTAGES

(*Clauses* 8.2.1, 8.4.2, 8.7, 8.14.1, 9.9.3, *and* 9.11.1)

Sl No.	Rated Resistance	Measuring Voltage +0 −10 percent
(1)	(2)	(3)
	(ohms)	(volts)
i)	<10	0·1
ii)	10 to 99	0·3
iii)	100 to 999	1
iv)	1 000 to 9 999	3
v)	10 000 to 99 999	10
vi)	100 000 to 999 999	25
vii)	≥1 000 000	50

8.2.2 The accuracy of the measuring equipment shall be such that the error does not exceed 10 percent of the tolerance. Where the measurement forms part of a test sequence, it should be possible to measure a change of resistance with an error not exceeding 10 percent of the maximum change permitted for that test.

8.2.3 The resistance value, at 27°C, between terminations *a* and *c* shall correspond with the rated resistance, taking account of the tolerance. The measurement shall be made with the moving contact having been set at the end of its travel by anticlockwise rotation of the adjustment device [*see* (a) and (b) of the Note].

Note — For special types of various resistors, it may be necessary to give further information on the measurement procedure, including the setting of moving contact, in the relevant specification, as given below:

a) For the variable resistor having continuous rotation and an angle of effective rotation less than but very close to 360° care is to be taken not to bridge the beginning and end of the continuous rotation by the moving contact, and

b) For the variable resistor having continuous rotation where each end of the resistance element is not brought out to separate terminations, the rated resistance shall be that resistance measured between terminations spaced 180° apart electrically with the moving contact positioned at one of these terminations.

8.3 Terminal Resistance

8.3.1 The measuring method shall give an accuracy of ±5 percent and the voltage applied to the variable resistor shall be so chosen that the limiting slider current is not exceeded.

8.3.2 The resistance shall be measured as follows:

a) between terminations *a* and *b* with the actuating device rotated in an anticlockwise direction until a minimum resistance is obtained, and

b) between terminations *c* and *b* with the actuating device rotated in a clockwise direction until a minimum resistance is obtained.

8.3.3 The terminal resistance shall not exceed that specified in the relevant specification.

8.4 Attenuation

8.4.1 Measurement shall be made between terminations *a* and *b* with the moving contact set at the anticlockwise end of the effective rotation except that for variable resistors having reverse non-linear laws, between *b* and *c*, with the moving contact set at the clockwise end of the effective rotation.

8.4.2 A voltage at 1 000 ± 200 Hz shall be applied across the terminations *a* and *c* of the variable resistor under test. The rms value of the voltage shall not exceed the dc voltages specified in Table 1. The voltage from *a* to *b* (or *b* to *c* where appropriate) shall be measured by an instrument having an internal impedance of at least 1 megohm; and this voltage, expressed as decibels below the applied voltage, is the attenuation to be measured.

8.4.3 The attenuation shall be not less than that given in the relevant specification.

8.5 Minimum Effective Resistance and Angle of Ineffective Rotation

8.5.1 *From Termination* a — The variable resistor shall be mounted as for measurement of angular rotation of the moving contact. An ohmmeter or other suitable measuring device shall be connected between terminations *a* and *b*. The moving contact shall then be set to the extreme anticlockwise position and the angular position recorded.

The moving contact shall be turned slowly clockwise until a progressive increase in resistance is indicated. The angular position shall then be recorded and the resistance shall be measured using the minimum practicable voltage. The angle between the two positions recorded above is the angle of the ineffective rotation. The resistance measured above is the value of the minimum effective resistance (from termination *a*).

8.5.2 *From Termination* c — Similar measurements as in **8.5.1**, shall be made from termination *c* by setting the moving contact at extreme clockwise position.

8.5.3 The value of minimum effective resistance and the angle of ineffective rotation shall not exceed that specified in the relevant specification.

8.6 Effective Resistance and Angle of Effective Rotation — The angle of effective rotation is the angle between the positions of minimum effective resistance recorded in **8.5.1** and **8.5.2**. The effective resistance is the difference between the resistance measured in **8.2** and the sum of the resistance measured in **8.5.1** and **8.5.2.**

8.7 Resistance Law — A voltage not exceeding the values given in Table 1 shall be applied to terminations *a* and *c* of the variable resistor and the voltage between *a* and *b* (or *b* and *c* where appropriate) shall be measured with a high impedance voltmeter.

The output ratio $\frac{V_{ab}}{V_{ac}}$ (or $\frac{V_{bc}}{V_{ac}}$ where appropriate) shall be within the limits given in the relevant specification when the moving contact is set at a selected point as specified.

The relevant specification may permit and prescribe the tolerance for a rate of change of resistance near to the end of the effective rotation less than that required by the prescribed law. It may also permit and prescribe the tolerance for approximations to the prescribed law of the form shown dotted in Fig. 1B.

The measuring method shall be such that the error does not exceed 10 percent of the tolerance or the appropriate ohmic tolerance stated in the relevant specification, whichever is the greater.

8.8 Switch Contact Resistance — Measurement of switch contact resistance may be carried out with dc or ac. In the case of dispute the dc measurement shall govern.

The contact resistance shall normally be calculated from the potential difference measured between the points intended for connection of the wiring. The contact shall be made before the measuring voltage is applied.

In order to prevent the breakdown of insulating films on the contacts, the emf of the measuring circuit shall not exceed 20 mV (dc or ac peak).

In order to prevent undue heating of the contacts, the current flowing shall not exceed 1A or the value specified in the relevant specification. For ac measurements the frequency shall be 1 kHz $\pm$ 200 Hz.

The measuring apparatus shall be such as to ensure an accuracy of $\pm$ 10 percent.

8.8.1 *Measuring Cycle*

a) *Measuring with dc* — One measuring cycle consists of:

1) making the contact,
2) connection of voltage source,
3) measurement with current flowing in one direction (*see* Note),
4) disconnection of voltage source, and
5) breaking the contact.

NOTE — Half the number of test specimens shall have the voltage connected in one phase sense and the other half in the other sense.

b) *Measurement with ac* — One measuring cycle consists of:

1) making the contact,
2) connection of voltage source,
3) measurement,
4) disconnection of voltage source, and
5) breaking the contact.

Measuring cycles shall be carried out in immediate succession.

8.8.2 *Measurement* — The contact resistance shall be measured between any two terminations that are to be connected by the contacting device.

Unless otherwise specified there shall be two measuring cycles. The average of the values thus obtained per contact is the contact resistance. The value of one measurement shall not exceed twice that of any other.

8.8.3 The contact resistance shall not exceed that specified in the relevant specification.

8.9 Voltage Proof (High Voltage)

8.9.1 Unless otherwise specified in the relevant specification the variable resistor shall be mounted in the normal manner on a metal plate which shall project not less than 6 mm beyond the variable resistor at all points.

8.9.2 *For Variable Resistor* — An alternating voltage of a frequency of 40 to 60 Hz and with a peak value of three times the limiting element voltage subject to a minimum of 500 volts and maximum of 2 kV shall be applied gradually at a rate of approximately 100 V per second until the proof voltage is obtained. At the discretion of the manufacturer the voltage may, however, be applied more rapidly. The proof voltage shall then be held for 1 minute $\pm$ 5 seconds between all variable resistor terminations connected together as one pole, and the spindle, metal parts and the plate connected together as the other pole.

8.9.3 *For Switch* — An alternating voltage of a frequency of 40 to 60 Hz with a value of 900 V rms for switches for supply mains $\leqslant$ 120 V and 2 U_R + 1 000 V rms for switches for supply mains > 120 V shall be applied gradually at a rate of approximately 100 V per second until the proof voltage is obtained. At the discretion of the manufacturer the voltage may, however, be applied more rapidly. The proof voltage shall then be held for 1 minute ± 5 seconds between all switch terminations connected together as one pole, and the spindle metal parts of the case and plate connected together as the other pole.

NOTE — U_R is the rated voltage of the switch.

8.9.4 The variable resistor shall withstand this test without breakdown or flashover.

8.10 Insulation Resistance

8.10.1 When mounted, as in **8.9.1**, the insulation resistance shall be measured between:

a) all variable resistor terminations connected together and all other external metal parts,

b) all switch contacts connected together and all other external metal parts, and

c) open switch contacts.

8.10.2 The insulation resistance shall be measured with a direct voltage as given below:

Rated Voltage	*Test Voltage*
Less than 500 V	100 ± 15 V
Equal to or greater than 500 V	500 ± 50 V

8.10.3 The insulation resistance so measured shall not be less than the value specified in the relevant specification.

8.11 Temperature Characteristic of Resistance

8.11.1 The variable resistor shall be dried using either Procedure I or II of **7.5** as called for in the relevant specification.

8.11.2 Unless otherwise specified in the relevant specification, the variable resistor shall be maintained at each of the following ambient temperature in turn:

a) 27 ±3°C,

b) Lower category temperature ±3°C,

c) 27 ±3°C,

d) 70 ± 2°C,

e) Upper category temperature ±2°C,

f) 70 ± 2°C, and

g) 27 ± 3°C.

The temperature listed at (d) and (f) are only applicable to variable resistors having an upper category temperature of 125°C or higher.

8.11.3 Resistance measurements shall be made according to the method of **8.2** at each of the temperatures specified in **8.11.2**, 10 to 15 minutes after the variable resistor has reached thermal stability.

The temperature of chamber at the time of resistance measurement shall be recorded. The error in the measurement of the temperature shall not exceed 1°C.

8.11.4 The temperature characteristic of resistance between 27°C and each of the other temperatures specified in **8.11.2** shall be computed from the following formula:

$$\text{Temperature characteristic of resistance} = \frac{100\ \Delta R}{R} \text{ percent.}$$

If the resistances recorded in **8.11.3** are designated as R_a, R_b, R_c, R_d, R_e, R_f, and R_g respectively, the values of R and ΔR shall be as given below:

	Lower Category Temperature	*Upper Category Temperature*	27°C to 70°C
R	$\frac{R_a + R_c}{2}$	$\frac{R_c + R_g}{2}$	$\frac{R_c + R_g}{2}$
ΔR	$R_b - R$	$R_e - R$	$\frac{R_d + R_f}{2} - R$

8.11.5 The temperature characteristic shall be as specified in the relevent specification.

8.12 Noise

8.12.1 One of the following methods shall be used for the measurement of noise of the variable resistors. Method 1 only applies when the wiper current is very low compared with the current passing through the resistance element. For all other cases, Method 3 is preferred.

8.12.2 *Method 1 — Rotational Noise*

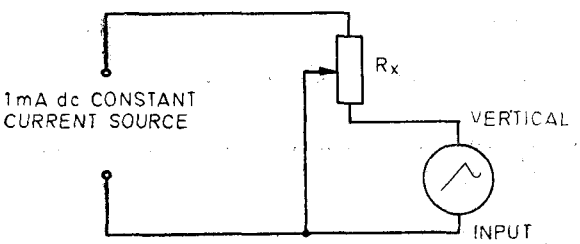
8.12.2.1 The noise output between terminations *a* and *b* (or between *b* and *c* where appropriate) shall not exceed that specified in the relevant specification when the variable resistor is measured as specified below:

A direct voltage of 20 V, with a source resistance of 1 000 ohms, shall be applied to the end terminations *a* and *c* of the variable resistor. The moving contact shall be operated through the angle of total mechanical rotation excluding the switch in one direction and back at 10 to 17 complete cycles per minute.

8.12.2.2 A typical test set up for the measurement of rotational noise is under consideration.

8.12.3 *Method 2 — Peak Noise (Equivalent Noise Resistance, ENR)*

8.12.3.1 The equivalent noise resistance (ENR) shall be measured with a suitable apparatus as shown in Fig. 6. During the test the moving contact shall be operated at such a speed as to traverse the full variation of the resistance in 10 to 30 seconds in each direction unless otherwise prescribed in the relevant specification.



R_x = Specimen Under Test
Oscilloscope Bandwidth dc 0 to 50 kHz
Minimum Input Impedance 1·0 megohm at 400 Hz

FIG. 6 MEASUREMENT OF PEAK NOISE

8.12.3.2 The equivalent noise resistance shall be calculated using the following formula :

$$R_{EN} = \frac{E_{PN}}{10^{-3}} \text{ ohms}$$

where

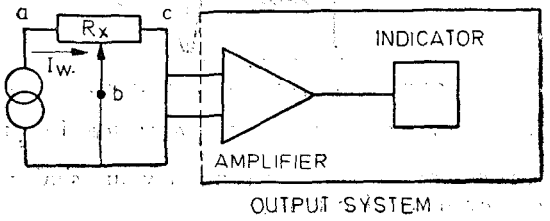
R_{EN} = equivalent noise resistance, and

E_{PN} = the peak noise signal voltage.

8.12.3.3 The equivalent noise resistance value shall not exceed that specified in the relevant specification.

8.12.4 *Method 3 — Contact Resistance Variation*

8.12.4.1 The contact resistance variation shall be measured with the measuring set up given in Fig. 7 or its equivalent.



R_x = Variable Resistor Under Test

FIG. 7 MEASUREMENT OF CONTACT RESISTANCE VARIATION

The constant current I_w is determined from the rated resistance of the variable resistor, as given below:

R_n	I_w
$\geqslant$ 2·2 MΩ	0·01 mA
$\geqslant$ 100 kΩ and $<$ 2·2 MΩ	0·05 mA
$\geqslant$ 10 kΩ and $<$ 100 kΩ	0·1 mA
$\geqslant$ 1 kΩ and $<$ 10 kΩ	1 mA
$\geqslant$ 100 Ω and $<$ 1 kΩ	10 mA
$<$ 100 Ω	50mA

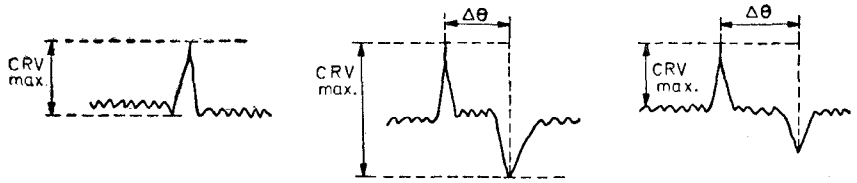
The values of I_w specified above are applicable, provided the limiting wiper current is not exceeded and the power dissipation through the resistive element does not exceed the rated power.

NOTE — Band width of the output system at 3dB is 90 Hz to 50 kHz and attenuation is 6 dB per octave outside the band width. If the input impedance of the output system is considered to be equivalent to a resistance R_{eg} with a capacity C_{eq} in parallel, it is required that:

$$R_{eg} \geqslant 10 \geqslant R_n$$
$$C_{eq} \leqslant 33 \text{ pF}$$

8.12.4.2 Unless otherwise specified, the moving contact shall be operated through 90 percent of the actual effective electrical travel in both directions for a total of six cycles. The rate of rotation shall be such that the moving contact completes 1 cycle in 5 seconds minimum, to 2 minutes maximum. The measurement of the contact resistance variation shall be made during the execution of the last 3 cycles.

8.12.4.3 Three typical contact resistance variation patterns are shown in Fig. 8. Contact resistance variation shall be expressed in percentage of the rated resistance, and $\Delta\theta$ as a percentage of the rated total mechanical travel.



CRV — Contact Resistance Variation

FIG. 8 CONTACT RESISTANCE VARIATION PATTERNS

8.12.4.4 The contact resistance variation value shall not exceed that specified in the relevant specification.

8.13 Temperature-Rise

8.13.1 The resistor shall be mounted in free air at an ambient temperature between 15°C and 35°C.

The voltage to be applied shall be the rated dissipation.

Connections are made in the usual manner. For resistors with soldering tags, copper wire of approximately 1·0 mm diameter shall be used for connecting the resistors. Special mounting arrangements, if any, shall be as described in the relevant specification.

8.13.2 The temperature at the hottest point on the surface of the resistor shall be measured after temperature equilibrium has been attained.

8.13.3 The temperature-rise shall not be more than the maximum permissible temperature-rise stated in the relevant specification.

NOTE 1 — The temperature measuring device shall be of such dimensions as not to affect the measurement.

NOTE 2 — No other ventilation shall be allowed than the ventilation provided by the resistor.

8.14 Matching of the Resistance Law (for Random Variable Resistors Only)

8.14.1 A voltage not exceeding the value given in Table 1 shall be applied to the terminations *a* and *c* of both variable resistors of the pair.

The voltage across *a* and *b*, and *c* and *b* for linear law variable resistors, or across *a* and *b* for logarithmic law variable resistors, or across *c* and *b* for reverse logarithmic law variable resistors, on *one* of the variable resistors shall be compared with the corresponding voltage on the other variable resistor at the identical setting of the control spindle.

NOTE — In the case of random variable resistors encasing more than two variable resistors, the above test shall be performed taking one as a reference and comparing with the others as above.

8.14.2 The relationship between these two voltages shall be within the limits given in the relevant specification.

8.15 Tests for Precision Variable Resistors Only

8.15.1 *Taps*

8.15.1.1 This measurement shall be done in accordance with **8.5.1**. A tap is indicated by a minimum resistance reading between the contact arm termination and another termination. If a tap extends over an appreciable area, the location of the tap shall be considered as being at the mid-point of the tap. During this test precaution shall be taken to ensure that the rated current of the resistance element is not exceeded.

8.15.1.2 The location of taps shall be as specified.

8.15.2 *Function Conformity Tolerance*

8.15.2.1 Conformity measurements shall be performed at intervals of not more than 2·5 percent of the actual angle of effective rotation or 45°C, whichever is less unless otherwise specified. The resistor shall be tested without load, unless otherwise specified. Measurements shall be performed by using a dc potential of low enough value to ensure that its application for the time necessary to obtain readings does not appreciably affect the measured values. For both linear and non-linear functions, the method employed for the measurement of conformity shall be such that the combined inherent errors of the measuring instruments shall not exceed the value specified. Ganged units shall be tested as specified in the relevant specification.

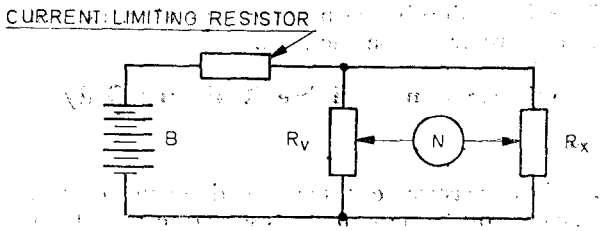
8.15.2.2 The applicable function shall be as specified in the relevant specification.

8.15.2.3 The function conformity tolerance shall be within the specified limits.

8.15.3 *End-Voltage*

8.15.3.1 Resistors shall be connected in a circuit similar to the one shown in Fig. 9. The contact arm shall be positioned at anticlockwise limit so that minimum voltage exists between it and corresponding end termination. The voltage shall be measured between the anticlockwise termination and the contact arm termination. The contact arm shall then be positioned at the clockwise limit of actual effective electrical travel. With the contact arm in this position, the voltage between the clockwise termination and the contact arm termination shall be measured.

8.15.3.2 The end voltage shall be within the limits as specified.



R_x = Test Specimen
R_v = Voltage Divider
N = Null Indicator
B = dc Voltage Source

FIG. 9 MEASUREMENT OF END VOLTAGE AND MECHANICAL BACKLASH

9. MECHANICAL TESTS

9.1 Visual Examination — The condition, workmanship and finish shall be satisfactory. Marking shall be legible and indelible (*see* **5** and **6**).

9.1.1 *Dimensions* — The dimensions shall be checked and the total mechanical rotation shall be measured. They shall comply with the values specified in the relevant specification.

9.2 Operating Torque — When set at a random position away from end stops or slipping clutch, if fitted, the torque necessary to operate the moving contact in either direction shall be as specified in the relevant specification.

NOTE — Where requirements for running torque uniformity exists, they shall be as specified in the relevant specification.

9.3 Switch Torque — The torque necessary to operate the switch shall not exceed that specified in the relevant specification, but it shall be at least twice the operating torque as measured in **9.2**.

9.4 End Stop Torque

9.4.1 Where the variable resistor is fitted with a slipping clutch, the moving contact shall be adjusted to each extreme limit of the mechanical travel and a torque shall be applied to the actuating device to force the moving contact to idle for five complete turns of the actuating device. During the rotation of the lead screw, a suitable electrical indication device shall be connected between termination *b* and the electrical termination adjacent to the moving contact. There shall be no electrical discontinuity.

9.4.2 After the test, the moving contact shall be capable of operating in its normal manner. The torque required to slip the clutch shall not exceed five times the maximum specified starting torque.

9.4.3 There shall be no deformation or other visible damage when the control spindle is set against each end stop in turn and a torque as specified in the relevant specification is applied to the control spindle for 10 seconds.

9.5 Locking Torque

9.5.1 Variable resistors fitted with locking bush shall be mounted on a metal panel by the normal means of mounting and the spindle set between 40 percent and 60 percent of its total rotation. The locking bush shall be tightened using the torque values specified in the relevant specification and the value of $\frac{V_{ab}}{V_{ac}}$ shall be measured.

9.5.2 The torque value prescribed in the relevant detail specification shall be applied to the spindle of the variable resistor and the value of $\frac{V_{ab}}{V_{ac}}$ shall be measured again.

9.5.3 The change in the value of $\frac{V_{ab}}{V_{ac}}$ shall not exceed the limit prescribed in the relevant specification. The locking torque shall be removed and the bushing and threads of the variable resistor examined. There shall be no visible damage.

9.6 Thrust and Pull on Spindle

9.6.1 The variable resistor shall be rigidly mounted by its normal means.

9.6.2 A thrust followed (where applicable) by a pull as specified below shall be applied to the control spindle in the direction along its axis and under these conditions the electrical continuity shall be checked.

In both cases the requirements for electrical continuity as specified in **8.1** shall be fulfilled.

Spindle Diameter	*Thrust/Pull*
mm	N
$> 5{\cdot}5$	25
$\leqslant 5{\cdot}5$	10

9.6.3 The control spindle shall be set at approximately mid-travel and held in such a manner so as to prevent rotation and the resistance between terminations *a* and *b* or between *c* and *b* for variable resistors having reverse non-linear laws shall be measured. A thrust of value given in **9.6.2** shall be applied to the control spindle in the direction along its axis and under these conditions the resistance between terminations *a* and *b* or between *c* and *b* where appropriate, shall again be measured. The test shall be repeated with a pull with a value given in the above table in the direction

along the axis of the control spindle. The change of resistance compared with the value measured without thrust or pull shall not exceed that specified in the relevant specification.

For precision variable resistors, the total axial excursion of the spindle measured at the end of the spindle during the test in **9.6.2** shall not exceed that specified in the relevant specification.

9.6.4 A thrust as specified below shall be applied to the control spindle in the direction along its axis for 10 seconds followed by a pull along the direction of the axis of the control spindle for 20 seconds. There shall be no visible damage.

Spindle Diameter	*Thrust/Pull*
mm	N
$> 5{\cdot}5$	125
$\leqslant 5{\cdot}5$	50

NOTE — For variable resistors having a body diameter or width of less than 14·5 mm the conditions of test shall be specified in the relevant specification.

9.7 Robustness of Terminations — The variable resistors shall be subjected to the procedure given in **7.19** of IS : 589-1961* as appropriate.

9.7.1 *Tensile Test* — This test shall be carried out in accordance with **7.19.1** of IS : 589-1961*. The force (loading weight) to be applied for 10 seconds shall be as given below, unless otherwise specified in the relevant specification:

a) For all types of terminations except wire terminations — 20 N

b) For wire terminations:

Cross-Sectional Area of Terminal	*Corresponding Nominal Diameter of Round Terminal*	*Force*
A (mm^2)	d (mm)	N
$A \leqslant 0{\cdot}07$	$d \leqslant 0{\cdot}3$	2·5
$0{\cdot}07 < A \leqslant 0{\cdot}2$	$0{\cdot}3 < d \leqslant 0{\cdot}5$	5
$0{\cdot}2 < A \leqslant 0{\cdot}5$	$0{\cdot}5 < d \leqslant 0{\cdot}8$	10
$A > 0{\cdot}5$	$d > 0{\cdot}8$	20

9.7.2 *Bend Test*

NOTE — Bending test shall not be made if the relevant specification describes the terminations as rigid.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

9.7.2.1 *Wire terminations* — The bend test on wire terminations shall be carried out in accordance with **7.19.2.2** of IS : 589-1961*. Care shall be taken to ensure that the bend occurs at a point 6 mm away from the point of emergence of the wire from the variable resistor and around a radius of 0·75 mm. A suitable arrangement to ensure this requirement is shown in Fig. 10. The required number of bends shall be two and there shall be no visible damage.

NOTE — This test shall be carried out on one-half of the specimens while the torsion test (*see* **9.7.3**) shall be carried out on the other half terminations.

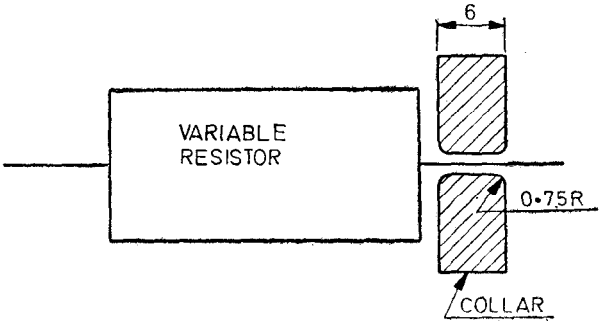


FIG. 10 ARRANGEMENT FOR BEND TEST

9.7.2.2 *Tag terminations* — The bending test on tag terminations shall be carried out in accordance with **7.19.2.3** of IS : 589-1961*. Each soldering tag shall be subjected to two cycles of bending without visible damage to the variable resistor.

9.7.3 *Torsion*

9.7.3.1 *Wire terminations* — The torsion test on wire termination shall be carried out in accordance with **7.19.3** of IS : 589-1961*. The required number of successive rotations which shall be three, shall be performed and there shall be no visible damage to the variable resistor.

9.7.3.2 *Nuts and threaded terminations* — The torsion test on nuts and threaded terminations shall be carried out in accordance with **7.19.4** of IS : 589-1961*. There shall be no visible damage to the variable resistor after this test.

9.8 Soldering (Solderability and Resistance to Soldering Heat)

9.8.1 The solder bath method shall be the preferred method for variable resistors. Where the solder bath method is not appropriate, the soldering iron of 8 mm bit size (*see* **7.18.3** of IS : 589-1961*) shall be used unless otherwise specified in the relevant specification.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

9.8.2 The variable resistors shall be dried using either Procedure I or II of **7.5** as specified in the relevant specification.

9.8.3 *Solderability*

9.8.3.1 The variable resistors shall be subjected to this test in accordance with **7.18** of IS: 589-1961* as specified in the relevant specification.

9.8.3.2 The terminations stated by the manufacturer to be suitable for use with printed wiring shall be immersed up to 2 mm from the point where the termination emerges from the body of the variable resistor, using a thermal screen as specified in **7.18** of IS : 589-1961*.

9.8.3.3 The variable resistor shall be visually examined. There shall be no visible damage.

9.8.4 *Resistance to Soldering Heat*

9.8.4.1 The resistance between terminations *a* and *c* shall be measured as specified in **8.2**.

9.8.4.2 The variable resistors shall be subjected to this test in accordance with **7.18** of IS : 589-1961*.

9.8.4.3 The variable resistors shall then be allowed to remain under the standard atmospheric conditions for recovery for $4 \pm \frac{1}{2}$ hours, unless it may be demonstrated that stability is reached earlier.

9.8.4.4 The resistance between terminations *a* and *c* shall be measured and the change in resistance compared with that measured in **9.8.4.1** shall not exceed that specified in the relevant specification.

9.8.4.5 The terminal resistance shall be measured as specified in **8.3** and shall be less than that specified in the relevant specification.

9.9 Vibration

9.9.1 The resistance between terminations *a* and *c* shall be measured as specified in **8.2**.

9.9.2 The variable resistors shall be subjected to the vibration test in accordance with **7.6** of IS : 589-1961* using the appropriate degree of severity. The relevant specification shall specify both the method of mounting to be used and degree of severity.

9.9.3 *For Preset Variable Resistors* — The moving contact shall be set at between 40 percent and 60 percent of the total mechanical rotation. A voltage not exceeding the voltages given in Table 1 shall be applied to terminations *a* and *c* of the variable resistors and the voltage between terminations

*Basic climatic and mechanical durability tests for electronic components (*revised*).

a and b shall be measured with a high impedance voltmeter. The output ratio $\frac{V_{ab}}{V_{ac}}$ shall be calculated.

The resistance between terminations a and b shall be measured as specified in **8.2.**

9.9.4 *For Variable Resistors not Fitted with Locking Device* — The moving contact shall be set at between 40 percent and 60 percent of the total mechanical rotation unless this operation has been performed as part of requirements of **9.9.3.** Electrical continuity between the moving contact and the resistance element shall be checked by oscillographic or other suitable means and shall be maintained.

9.9.5 *For Variable Resistors Fitted with an Integral Locking Device* — The moving contact shall be set and locked between 40 percent and 60 percent of the total mechanical rotation unless this operation has been performed as part of the requirements of **9.9.3.**

9.9.6 Throughout the test the resistors shall be connected to a suitable monitoring device to determine electrical discontinuity between terminations a and b or a and c as specified. There shall be no discontinuity.

During the test, any transient resistance changes of the resistance between terminations a and b or, if the resistance between c and b is smaller, between these latter terminations shall not exceed that specified in the relevant specification.

9.9.7 After the test, the variable resistors shall be visually examined, there shall be no visible damage.

9.9.8 For preset variable resistors, the output ratio $\frac{V_{ab}}{V_{ac}}$ shall be determined as given in **9.9.3.** The percentage change in output ratio compared with that measured in **9.9.3** shall not exceed that prescribed in the relevant specification.

9.9.9 The resistance between terminations a and c shall be measured and the change in resistance with respect to that measured in **9.9.1** shall not exceed that prescribed in the relevant specification.

9.10 Bump

9.10.1 The resistance between terminations a and c shall be measured as specified in **8.2.**

9.10.2 The variable resistors shall be subjected to this test in accordance with **7.5.1** of IS : 589-1961* using the appropriate degree of severity.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

The relevant specification shall state degree of severity and the temperature(s) at which the test shall be performed and the method of mounting to be used.

9.10.3 Throughout the test, resistors shall be connected to a suitable monitoring device to determine electrical discontinuity between terminations *a* and *b* or *a* and *c* as specified. There shall be no discontinuity.

9.10.4 After the test the variable resistors shall be visually examined. There shall be no visible damage.

9.10.5 The resistance between terminations *a* and *c* shall be measured and the change of resistance compared with that measured in **9.10.1** shall not exceed that specified in the relevant specification.

9.11 Shock

9.11.1 The resistance between terminations *a* and *c* shall be measured as specified in **8.2.**

The moving contact shall be set at between 40 percent and 60 percent of the total mechanical rotation, and variable resistors fitted with a locking device shall be locked at that position.

In addition, but only for preset variable resistors, a voltage not exceeding the voltage given in Table 1 shall be applied to terminations *a* and *c* of the variable resistor and the voltage between terminations *a* and *b* shall be measured with a high impedance voltmeter. The output ratio $\frac{V_{ab}}{V_{ac}}$, expressed in percent, shall be calculated.

9.11.2 The variable resistor shall be subjected to this test in accordance with **7.5.2** of IS : 589-1961*, taking into account the following additions:

Mounting	:	Variable resistors shall be mounted by their normal means, in such a manner that there shall be no parasitic vibration.
Pulse shape	:	Semi-sinusoidal.
Severity	:	Acceleration (peak-value) : 294 m/s^2 or 490 m/s^2 as prescribed in the relevant specification.
Duration	:	11 milliseconds.

NOTE — The acceleration of 490 m/s^2 is preferred.

9.11.3 During the test, the variable resistor shall be monitored for electrical discontinuity, in excess of 100 microseconds or greater, between the terminals *a* and *b*. There shall be no interruptions during the test.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

9.11.4 The variable resistors shall be visually examined. There shall be no visible damage.

9.11.5 The resistance between terminations *a* and *c* shall be measured and change in resistance with respect to that measured in **9.11.1** shall not exceed the value prescribed in the relevant specification.

9.11.5.1 For preset variable resistors, the output ratio $\frac{V_{ab}}{V_{ac}}$ shall be determined as specified in **9.11.1.** The percentage change in output ratio compared with that measured in **9.11.1** shall not exceed the value prescribed in the relevant specification.

9.12 Acceleration (Steady State)

9.12.1 The resistance between terminations *a* and *c* shall be measured as specified in **8.2.**

The moving contact shall be set at between 40 and 60 percent of the total mechanical rotation, and variable resistors fitted with a locking device shall be locked at that position.

9.12.2 The variable resistors shall be subjected to this test in accordance with **7.7** of IS : 589-1961*, using the appropriate severity, as specified in the relevant specification.

9.12.3 Throughout the test the specimens shall be connected to a suitable monitoring device to determine electrical discontinuity between terminations *a* and *b* or *a* and *c* as specified. There shall be no discontinuity.

9.12.4 After the test the variable resistors shall be visually examined. There shall be no visible damage.

9.12.5 The resistance between terminations *a* and *c* shall be measured and the change of resistance compared with that measured in **9.12.1** shall not exceed that specified in the relevant specification.

9.13 Tests for Precision Variable Resistors Only

9.13.1 *Mechanical Accuracy*

9.13.1.1 *Lateral runout* — The test set up for this measurement is given in Fig. 11. The operating spindle shall be clamped vertically in a suitable device. The dial indicator is positioned such that its probe contacts the smooth portion of the mounting surface of the variable resistor less than 3 mm from the outside edge of the mounting surface. The probe shall be depressed sufficiently to ensure a proper positive and negative indication. A load of 2·5 N, unless otherwise specified, is applied, normal to the

*Basic climatic and mechanical durability tests for electronic components (*revised*).

centreline of the spindle axis, on the resistor body within 3 mm of the mounting surface. Simultaneously a load of 2·5 N is applied axially on the centreline of the resistor. The resistor body shall be rotated through the angle of total mechanical rotation or 360°, whichever is less. The lateral runout shall be determined from the maximum positive and negative deviations added together without regard to the algebric signs. The dial reading shall then be divided by the mounting surface radius, at the point of dial measurement.

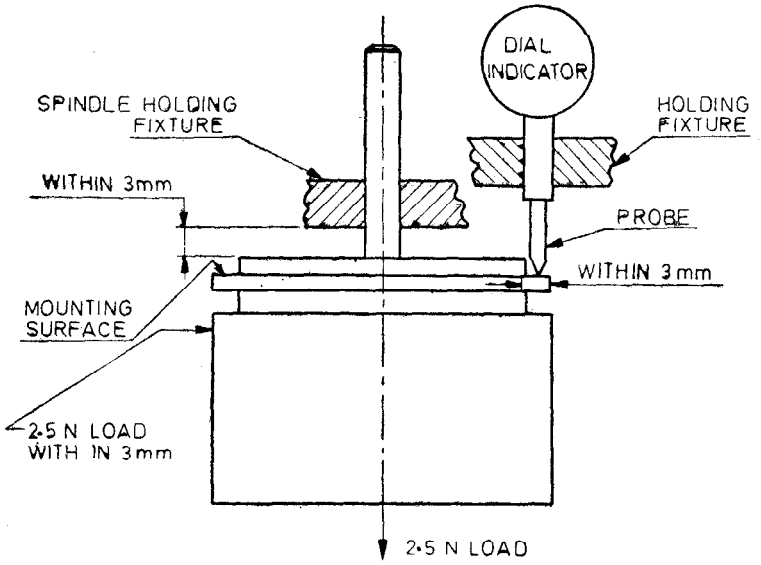
9.13.1.2 *Spindle runout* — The test set up for this measurement is given in Fig. 12. The resistors shall be mounted by their normal mounting means in a horizontal position. A dial indicator is positioned such that the probe contacts the operating spindle as close to the end of the spindle as possible with a load of 2·5 N applied radially near the end of the spindle. The operating spindle shall be rotated through the angle of total mechanical rotation or 360°, whichever is less. The spindle runout shall be determined from the maximum positive and negative deviations added together without regard to the algebraic science. The dial reading shall then be divided by the length of the spindle from the mounting surface to the point of dial measurement.

9.13.1.3 *Pilot surface runout* — This test shall be performed in accordance with Fig. 13. The operating spindle shall be clamped in a suitable device within 3 mm of the front surface of the variable resistor. The dial indicator is positioned such that its probe contacts the periphery of the pilot surface near the mid-point of the surface. The probe is depressed sufficiently to ensure a proper positive and negative indication. A load of 2·5 N is applied normal to the centreline of the spindle axis on the resistor body. The resistor body shall be rotated through the angle of total mechanical rotation or 360°, whichever is less. The runout of the pilot surface shall be the maximum positive and negative deviations added together without regard to algebraic signs.

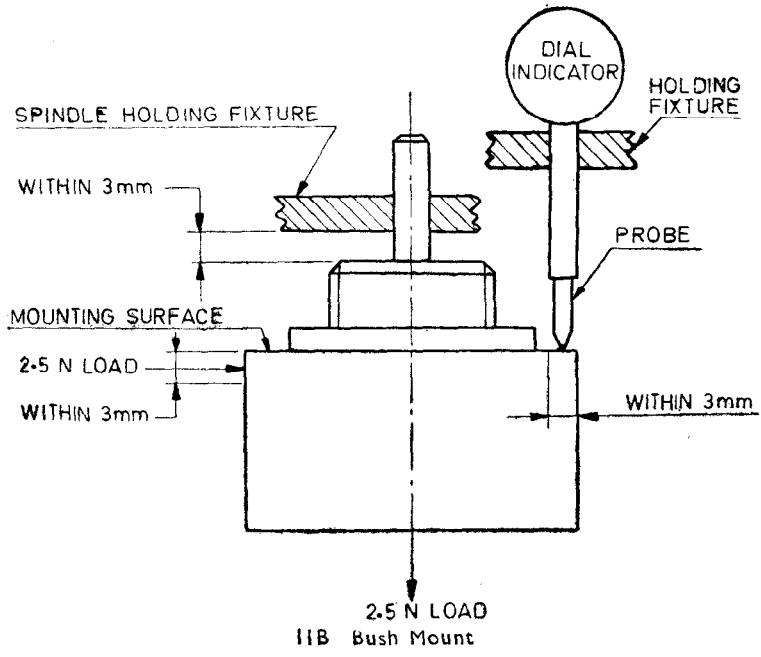
9.13.1.4 Values of lateral runout, spindle runout and pilot surface runout, shall be within the limits specified in the relevant specification.

9.13.2 *End Play*

9.13.2.1 The test set up for this measurement is given in Fig. 14. The dial indicator is positioned with its probe parallel (or normal if pivot pointer indicator is used) to the axis of the spindle and in contact with the end of the spindle on the centreline. The probe is depressed sufficiently to ensure a proper positive and negative indication. A load of 2·5 N is applied alternately in opposite directions along the axis of the spindle. The spindle end play is the total indicated reading determined by adding the maximum positive and negative readings without regard to the algebraic signs.

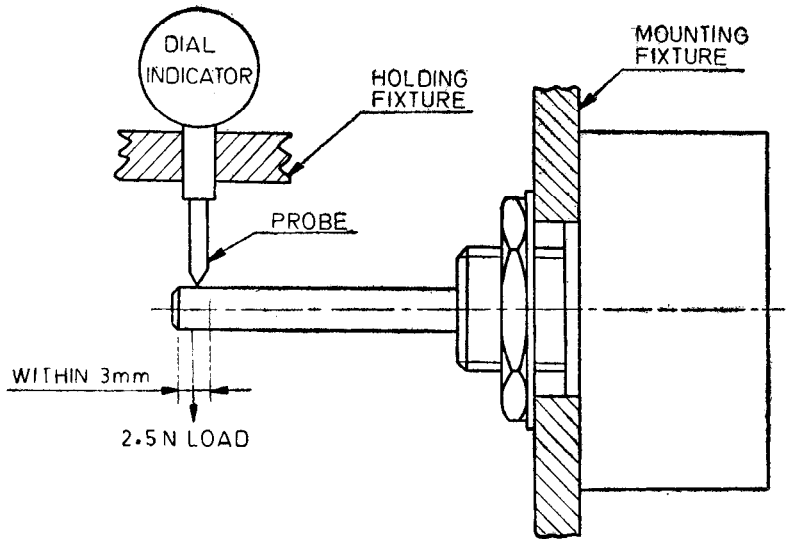


11A Servo Mount

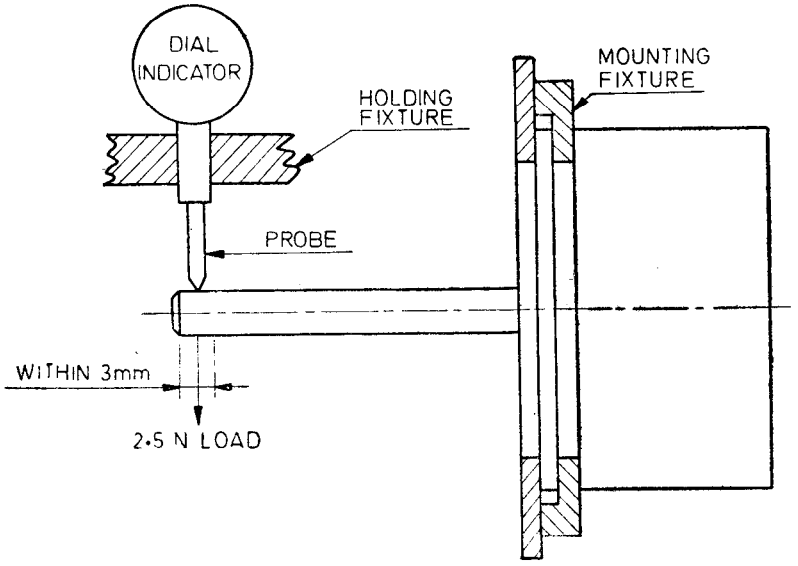


11B Bush Mount

FIG. 11 MEASUREMENT OF LATERAL RUNOUT



12A Bush Mount



12B Servo Mount

FIG. 12 MEASUREMENT OF SPINDLE RUNOUT

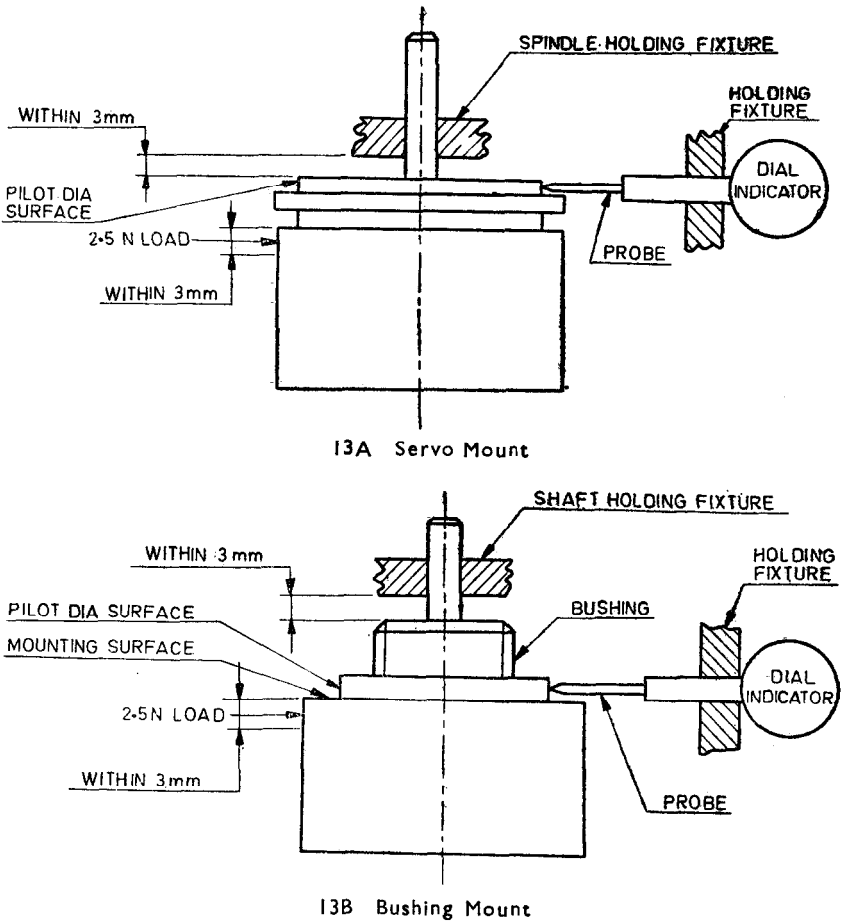


FIG. 13 MEASUREMENT OF PILOT SURFACE RUNOUT

9.13.2.2 The end play shall be within the limits specified in the relevant specification.

9.13.3 *Side Play*

9.13.3.1 The test set up for this measurement is given in Fig. 15. The resistor shall be mounted horizontally by its normal mounting means with a dial indicator positioned so that the probe will contact the operating spindle as close to the mounting surface as possible. A load of 2·5 N shall be applied radially to the operating spindle 12 mm from the mounting

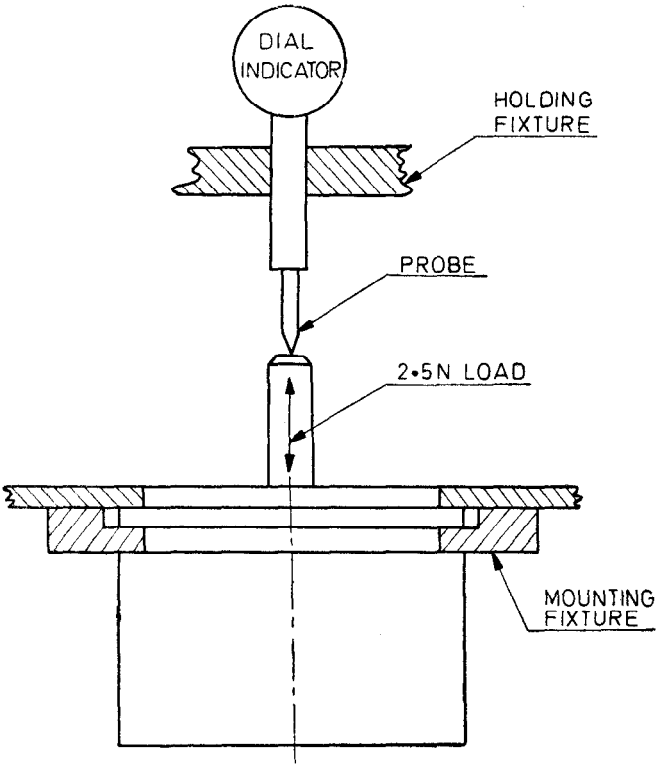


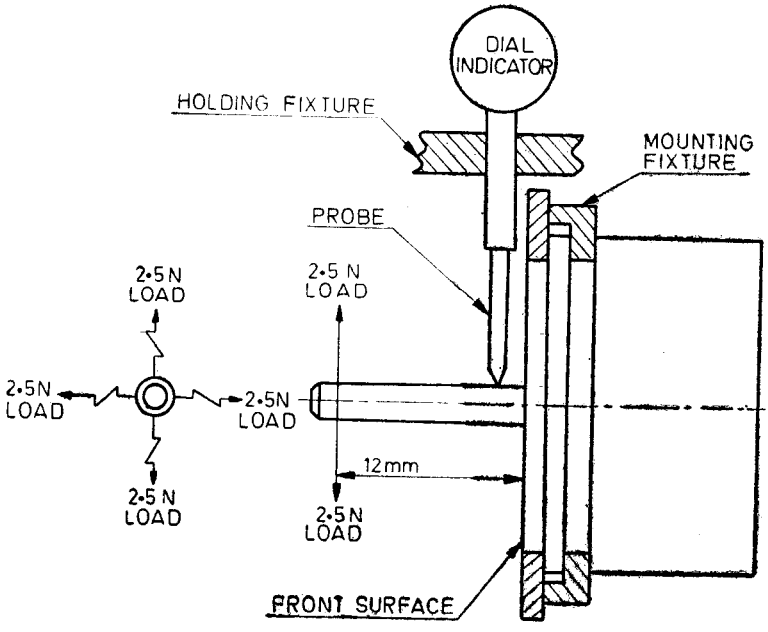
FIG. 14 MEASUREMENT OF END PLAY

surface in two opposite directions, one at a time first in the vertical plane and then in the horizontal plane. The side play shall be the positive and negative deviations added together without regard to the algebraic signs.

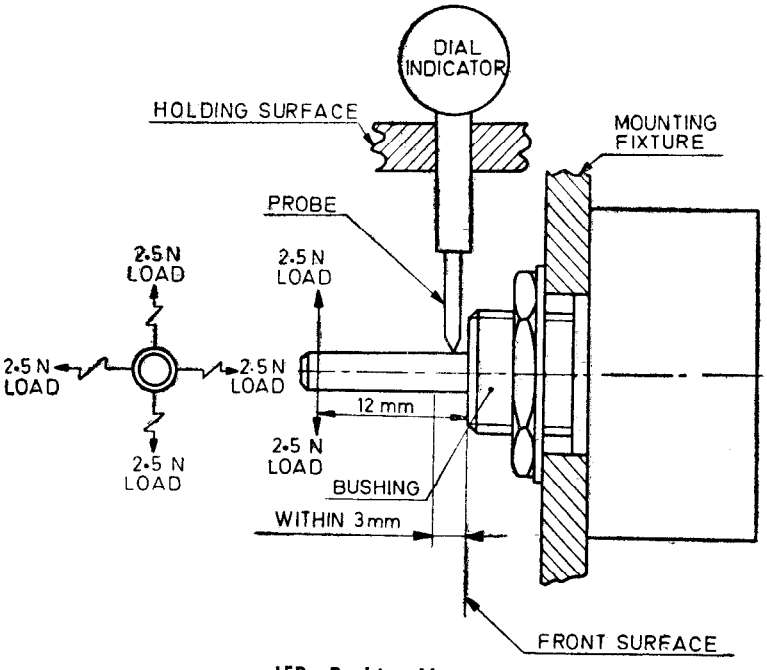
9.13.3.2 The side play shall be within the limit specified in the relevant specification.

9.13.4 *Mechanical Backlash*

9.13.4.1 Resistors shall be mounted in a suitable angle indicating device, and the moving contact shall be rotated to approximately 40 to 60 percent of total machanical rotation (not in tap area). For variable resistors having non-linear functions, the moving contact shall be rotated to the area of best resolution. Resistor shall then be connected in a circuit similar to that shown in Fig. 9. The voltage divider shall be adjusted to obtain zero indication on the null indicator. The moving contact shall



15A Servo Mount



15B Bushing Mount

FIG. 15 MEASUREMENT OF SIDE PLAY

be rotated in a clockwise direction to 10 to 20 percent of total mechanical rotation and shall then be rotated in a anticlockwise direction until the null indicator spindle reads zero. The angular position of the moving contact shall be noted. The moving contact shall be rotated in anticlockwise direction to 10 to 20 percent of total mechanical rotation. The moving contact shall be now rotated in a clockwise direction until the null indicator again reads zero and shall be continued in the same direction until a perceptible change in the null reading occurs. The angular position of the moving contact shall again be noted. The angular difference between the two positions shall be backlash.

9.13.4.2 The mechanical backlash shall not exceed that specified in the relevant specification.

9.13.5 *Total Mechanical Rotation*

9.13.5.1 The resistor shall be placed in a suitable angle indicating device, and the operating spindle shall be rotated from one stop to the other and held against the stops with a torque as specified. The angle of total mechanical rotation shall be determined from the number of degrees traversed between stops.

9.13.5.2 The total mechanical rotation shall be as specified in the relevant specification.

10. CLIMATIC TESTS

10.1 Climatic Sequence

10.1.1 *Initial Requirements*

10.1.1.1 The variable resistors shall be dried using either Procedure I or II of **7.5** as specified in the relevant specification.

10.1.1.2 The resistance between terminations *a* and *c* shall be measured as specified in **8.2.**

10.1.2 *Dry Heat*

10.1.2.1 The variable resistors shall be subjected to this test in accordance with **7.2** of IS : 589-1961* using the appropriate degree of severity.

10.1.2.2 Throughout the period of exposure, half the specimens shall be electrically loaded so that the dissipation corresponds to appropriate category dissipation.

10.1.2.3 While still at the specified high temperature, the insulation resistance shall be measured in accordance with **8.10** and shall not be less than the value specified in the relevant specification.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

10.1.2.4 After recovery the variable resistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

10.1.3 *Damp Heat (Accelerated), First Cycle*

10.1.3.1 The variable resistors shall be subjected to the first cycle of damp heat (accelerated) test in accordance with **7.4** of IS : 589-1961*.

10.1.3.2 After recovery, they shall be subjected immediately to the cold test.

10.1.4 *Cold*

10.1.4.1 The variable resistors shall be subjected to this test in accordance with **7.1** of IS : 589-1961*.

10.1.4.2 While still at the specified low temperature and at the end of the period of low temperature, the operating torque shall be measured.

The operating torque shall be measured as specified in **9.2.** The moving contact shall be operated once over the whole resistance element and back, using a torque not exceeding six times the maximum value specified in the relevant specification for operating torque (*see* **9.2**) but with an upper limit not exceeding that specified for end stop torque in **9.4.**

The operating torque of the variable resistor shall not exceed that specified in the relevant specification.

The operating torque of the switch shall be measured as specified in **9.3** and shall not exceed that specified in the relevant specification.

10.1.5 *Low Air Pressure*

10.1.5.1 The variable resistors shall be subjected to this test in accordance with **7.12** of IS : 589-1961* using the appropriate degree of severity.

10.1.5.2 The test shall be carried out between 15°C and 35°C and the duration of the test shall be one hour.

10.1.5.3 While still at the specified low pressure and during the last five minutes of one hour period, a voltage proof test in accordance with **8.9** shall be carried out. The test voltage shall be in accordance with that given in the relevant specification. During and after this test there shall be no sign of breakdown or flashover.

10.1.6 *Damp Heat (Accelerated), Remaining Cycles*

10.1.6.1 The variable resistors shall be subjected to this test in accordance with **7.4** of IS : 589-1961*.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

10.1.6.2 After the specified number of cycles the variable resistors shall be removed from the chamber; shaken so as to remove droplots of water, and within 15 minutes the voltage as specified in the relevant specification shall be applied for one minute between the terminations connected together and the spindle (where metallic) and/or the mounting plate (*see* **8.9**). There shall be no breakdown.

10.1.7 *Recovery* — The variable resistors shall be allowed to remain under standard atmospheric conditions for recovery for one to two hours.

10.1.8 *Final Measurements* — The final measurements shall be completed after the recovery prescribed in **10.1.7**, within the time limits as specified below:

a) Visual examination should be completed within one hour,

b) Resistance between terminations should be completed between one and two hours, and

c) All other measurements should be completed in not more than 6 hours.

The variable resistors shall be subjected to such of the following tests and measurements as prescribed in the relevant specification, after recovery:

a) The variable resistance shall be visually examined. There shall be no visible damage and the marking shall be legible.

b) The resistance between terminations *a* and *c* shall be measured and the change in resistance compared with that measured in **10.1.1.2** shall not exceed that specified in the relevant specification.

c) The insulation resistance shall be measured as specified in **8.10** and shall not be less than that specified in the relevant specification.

d) The noise shall be measured and shall be within limits as specified in the relevant specification.

e) The switch contact resistance shall be measured as specified in **8.8** and shall not exceed that specified in the relevant specification.

f) The continuity shall be tested as specified in **8.1** and the requirements of the relevant specification shall be met.

g) The operating torque shall be measured as specified in **9.2** and shall be within the limits specified in the relevant specification.

h) The voltage proof test shall be carried out as specified in **8.9** or as stated in the relevant specification. There shall be no breakdown or flashover.

k) The loading test as given below should be made immediately after the voltage proof test has been completed:

1) A voltage equal to the rated voltage or the limiting element voltage, whichever is less, shall be applied for one minute between terminations *a* and *c* of the variable resistors. The test is carried out under standard conditions for testing.

2) The variable resistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

3) The resistance and the insulation resistance shall be measured in accordance with **8.2** and **8.14** respectively. The change of resistance shall not exceed the value prescribed in the relevant specification, and the insulation resistance shall not be less than that prescribed in the relevant specification.

10.2 Damp Heat (Long Term)

10.2.1 The resistance between terminations *a* and *c* shall be measured as specified in **8.2**.

10.2.2 The variable resistors shall be subjected to this test in accordance with **7.3** of IS : 589-1961*, using the appropriate degree of severity.

10.2.3 Unless otherwise specified, a dc voltage as specified in the relevant specification shall be applied to half the specimens between the terminations as specified in the relevant specification. For the other half specimens no voltage shall be applied.

10.2.4 After this period the variable resistors shall be removed from the chamber and within 15 minutes the voltage as specified in the relevant specification applied for one minute between the terminations connected together and the spindle.

There shall be no breakdown.

10.2.5 *Recovery* — The variable resistors shall be allowed to remain under standard atmospheric conditions for recovery for one to two hours.

10.2.6 *Final Measurements* — The final measurements shall be completed after the recovery prescribed in **10.2.5** within the time limits as specified below:

a) visual examination should be completed within one hour,

b) resistance between terminations should be completed between one and two hours, and

c) all other measurements should be completed in not more than 6 hours.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

The variable resistors shall be subjected to such of the following tests and measurements as prescribed in the relevant specification, after recovery:

a) The variable resistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

b) The resistance between terminations *a* and *c* shall be measured and the change in resistance compared with that measured in **10.2.1** shall not exceed that specified in the relevant specification.

c) The insulation resistance shall be measured as specified in **8.10** and shall not be less than that specified in the relevant specification.

d) The resistance law shall be checked.

e) The switch contact resistance shall be measured as specified in **8.8** and shall not exceed that specified in the relevant specification.

f) The continuity shall be tested as specified in **8.1** and the requirements of the relevant specification shall be met.

g) The operating torque shall be measured as specified in **9.2** and shall be within the limits specified in the relevant specification.

h) The noise shall be measured and shall not exceed that specified in the relevant specification.

j) The voltage proof test shall be carried out as specified in **8.9** or as stated in the relevant specification. There shall be no breakdown or flashover.

k) The loading test as given below should be made immediately after the voltage proof test has been completed:

1) A voltage equal to the rated voltage or the limiting element voltage, whichever is the less, shall be applied for one minute between terminations *a* and *c* of the variable resistors. The test is carried out under standard conditions for testing.

2) The variable resistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

3) The resistance and the insulation resistance shall be measured. The change of resistance shall not exceed the value prescribed in the detail specification, and the insulation resistance shall not be less than that prescribed in the relevant specification.

m) The variable resistors shall withstand satisfactorily the solderability test in accordance with **9.8.3**.

10.3 Salt Mist

10.3.1 The variable resistors shall be subjected to the salt mist test in accordance with **7.10** of IS : 589-1961*. The period of exposure shall be as specified in the relevant specification.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

After the exposure, the variable resistors shall be visually examined. There shall be no visible damage.

10.4 Mould Growth — This test shall be carried out in accordance with **7.9** of IS : 589-1961*.

10.5 Rapid Change of Temperature

10.5.1 *Test A* — This test is only applicable to variable resistors having a difference between the upper and lower category temperature exceeding 95°C. The resistance between terminations *a* and *c* shall be measured as specified in **8.2.**

10.5.1.1 The variable resistors shall be subjected to five cycles in accordance with **7.14** of IS : 589-1961*. After recovery, the variable resistors shall be visually examined. There shall be no visible damage.

The resistance between terminations *a* and *c* shall be measured and the change in resistance compared with that measured in **10.5.1** shall not exceed that specified in the relevant specification.

10.5.1.2 For preset variable resistors only, the moving contact shall be set at between 40 percent and 60 percent of the total mechanical rotation. The resistance between terminations *a* and *b* shall be measured as specified in **8.2.**

The resistance between terminations *a* and *b* shall be measured and the change in resistance compared with that measured in **10.5.1** shall not exceed that specified in the relevant specification.

10.5.2 *Test B* — This test is similar to the Test A (*see* **10.5.1**) except as follows:

a) The duration of exposure in each chamber shall be 30 minutes.

b) The transfer time from one chamber to the other shall be 10 to 15 minutes during which period the variable resistance shall be in standard atmospheric conditions for testing.

11. MISCELLANEOUS TESTS

11.1 Resistance to Solvents — This test shall be carried out in accordance with IS : 9000 (Part XX)†.

11.1.1 The marking shall remain legible and shall not swear or obliterate. There shall be no mechanical deterioration.

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*Basic climatic and mechanical durability tests for electronic components (*revised*).

†Basic environmental testing procedures for electronic and electrical items: Part XX Resistance to cleaning solvents and performance or marking (*under preparation*).

11.2 Flammability — This test shall be carried out according to the procedure given in Appendix A.

11.3 Mechanical Endurance

11.3.1 *Variable Resistor*

11.3.1.1 The resistance between terminations *a* and *c* shall be measured as specified in **8.2.**

11.3.1.2 Unless otherwise specified each variable resistor shall be mounted by its normal means; half the specimens shall be loaded between terminations *a* and *c* the other half shall be unloaded.

For variable resistors not exceeding 10 watts of rated dissipation the use of dc voltage provided the ripple does not exceed 5 percent shall be the preferred method. If, however, it can be demonstrated that there will be no relaxation in the severity of the test, an ac voltage may be used, agreement being reached between the purchaser and the manufacturer. For those exceeding 10 watts rated dissipation, an ac voltage shall be applied. The applied voltage shall be the rated voltage or the limiting element voltage whichever is the less.

11.3.1.3 Unless otherwise specified (*see* Note), each variable resistor shall be mounted on a 1·6 mm thick steel panel having the dimensions given in the table below and placed in such a manner that the mounting point of any variable resistor is spaced, in any direction, from the mounting point of any other variable resistor by four times the diameter of the variable resistor.

Power Rating	*Panel Size*
	mm
$\leqslant$ 4 W	50 × 50
$>$ 4W	100 × 100

NOTE — Those variable resistors which are designed to be mounted by their terminations on printed wiring boards, shall be mounted during this test on a 1·6 mm thick glass base epoxy laminate board.

11.3.1.4 The variable resistors shall be subjected to this test in such a manner that the temperature of any one variable resistor shall not appreciably influence the temperature of any other variable resistor. There shall be no undue draught.

11.3.1.5 A suitable driving mechanism shall be fixed to the control spindle and arranged to operate cyclically so that the mechanical displacement is greater than 90 percent of the total mechanical rotation. The torque shall be not more than 200 mN.m for those exceeding 10 watts rated dissipation.

11.3.1.6 Unless otherwise specified in the relevant specification, number of cycles of operation and the rate of operation for single turn rotary variable resistors shall be as given in the table below:

Variable Resistor Type	*Number of Cycles of Operations*	*Cycle Rate (Cycles Per Minute)*
Rated dissipation $\leq$ 3 watts	25 000 or 10 000 as specified in the relevant specification	10 to 17
Rated dissipation $>$ 3 watts	5 000	5 to 10
Preset	200	5 to 10

NOTE — A cycle operation is defined as the travel of the moving contact from one end of the resistance element to the other and back. For other constructions of variable resistors, for example, multi-turn helical, continuous rotation, lead screw actuated, etc, the relevant specification shall specify the number of operations and the rate of operation. It shall also define a cycle of operation.

11.3.1.7 After the test the variable resistor shall be allowed to remain under standard atmospheric conditions for recovery for 1 to 2 hours. After this period such of the following tests as called for in the relevant specification shall be made:

a) The variable resistor shall be visually examined. There shall be no visible damage.

b) The resistance shall be measured between terminations *a* and *c* and the change in resistance compared with that measured in **11.3.1.1** shall not exceed that specified in the relevant specification.

c) The terminal resistance shall be measured as specified in **8.3** and shall not be less than that specified in the relevant specification.

d) The insulation resistance shall be measured as specified in **8.10** and shall not be less than that specified in the relevant specification.

e) The resistance law shall be checked.

f) The operating torque shall be measured as specified in **9.2** and shall be within the limits specified in the relevant specification.

g) The continuity shall be tested as specified in **8.1** and the requirements of the relevant specification shall be met with.

h) The thrust and pull on the spindle shall be tested as specified in **9.6** and the requirements of the relevant specification shall be met with.

j) The voltage proof test shall be carried out as specified in **8.9**. There shall bo no breakdown or flashover.

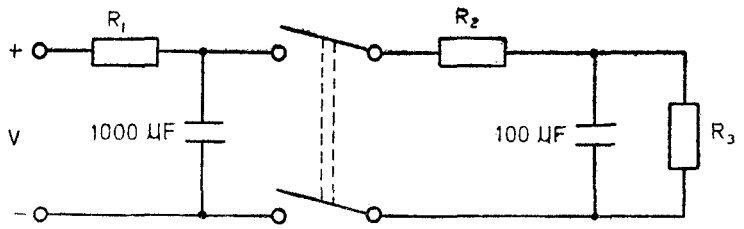
k) The noise shall be measured as specified in **8.12** and shall not exceed that specified in the relevant specification.

m) Where applicable, the sealing test shall be performed as specified in **11.5** and the requirements of the relevant specification shall be met with.

11.3.2 *Switch (When Fitted)*

11.3.2.1 The switch shall be subjected to 5 000 operations at 10 to 17 cycles per minute, on/off, being loaded as given in Fig. 16 and the following table and to a further 5 000 operations without load. During the 'off' part of the switching sequence, the switch contacts shall remain open for a period equal to or greater than one second.

NOTE — After 10 000 operations (*see* **11.3.2.2**) the switch shall be allowed to continue to operate up to the 25 000 operations required for the variable resistor but no further checks shall be made upon the switch.



NOTE — When a single pole switch is tested, it shall be connected in the positive line (between R_1 and R_2).

FIG. 16 DOUBLE POLE SWITCH UNDER TEST

Switch Application	*Volts* V dc	R_1 (*See* Note)	R_2	R_3
		Ω	Ω	Ω
Power supply ac	225	$\leqslant$ 225	15	4 700
Power supply ac/dc	225	$\leqslant$ 225	15	210
< 34 volts	34	$\leqslant$ 34	6·8	33

NOTE 1 — Resistor R_1 shall be so chosen that the 1 000 µF capacitor shall be fully charged between each cycle of operation of the switch. The charging current shall be not greater than 1 A.

NOTE 2 — A cycle of operation is the closing of the switch contacts followed by their opening.

11.3.2.2 After 10 000 operations the following tests shall be made:

a) The switch shall be visually examined externally. There shall be no visible damage.

b) The torque required to operate the switch shall be measured as specified in **9.3** and shall not be greater than that specified in the relevant specification.

c) The insulation resistance of the switch shall be measured as specified in **8.10** and shall not be less than that specified in the relevant specification.

d) The switch contact resistance shall be measured as specified in **8.8** and shall be not less than that specified in the relevant specification.

e) The voltage proof test shall be performed on the switch as specified in **8.9**. There shall be no breakdown or flashover.

11.4 Electrical Endurance

11.4.1 The resistance between terminations *a* and *c* shall be measured as specified in **8.2**.

11.4.2 The variable resistors shall be subjected to an electrical endurance test of 1 000 hours at an ambient temperature of 70 $\pm$ 2°C, unless otherwise specified in the relevant specification.

11.4.3 For variable resistors with a rated dissipation not exceeding 10 watts, the use of a dc voltage provided the ripple does not exceed 5 percent shall be the preferred method. If, however, it can be demonstrated that there will be no relaxation in the severity of the test, an ac voltage may be used, agreement being reached between the purchaser and the manufacturer. For variable resistors having a rated dissipation more than 10 watts an ac voltage shall be used. This voltage shall be the rated voltage or the limiting element voltage, whichever is the less.

At all times during the tests, the applied voltage shall be within $\pm$ 5 percent of the calculated voltage.

11.4.4 During the test, the voltage shall be applied in cycles of 1·5 hours on and 0·5 hours off to half the specimens between terminations *a* and *c*.

For the remaining specimens, the moving contact shall be set at 95 percent (or at 5 percent for variable resistors having reverse non-linear laws) of the angle of electrical rotation and the proportional voltage shall be applied to terminations *a* and *b* (*b* and *c* where appropriate) in cycles of 1·5 hours on and 0·5 hours off.

NOTE — The half-hour off periods are also included in the total test duration specified in **11.4.2**.

11.4.5 After the specified period they shall be allowed to cool to standard atmospheric conditions for testing. They shall then be subjected to such of the following tests as are called for in the relevant specification:

a) The variable resistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

b) The resistance shall be measured between terminations *a* and *c* and the change in resistance compared with that measured in **11.4.1** shall not exceed that specified in the relevant specification.

c) The insulation resistance shall be measured as specified in **8.10** and shall not be less than that specified in the relevant specification.

d) The rotational noise output shall be measured as specified in **8.12** and shall not exceed that specified in the relevant specification.

e) The continuity shall be tested as specified in **8.1** and the requirements of the relevant specification shall be met.

f) Where applicable, the sealing test shall be performed as specified in **11.5** and the requirements shall be within the limits.

11.5 Sealing

11.5.1 *For Spindle Sealed and Panel Sealed Variable Resistors* — The variable resistors shall be subjected to this test in accordance with **7.15.2** of IS : 589-1961*.

11.5.1.1 The rate of leakage or air shall not exceed 1 cm^3 per hour.

11.5.2 *For Container Sealed Variable Resistors* — The variable resistors shall be subjected to this test in accordance with **7.16** of IS : 589-1961*.

11.5.2.1 No bubbling shall occur.

APPENDIX A

(*Clause* 11.2)

FLAMMABILITY TEST

A-1. OBJECT

A-1.1 This test is intended to determine whether resistors will support combustion.

A-2. TEST CHAMBER

A-2.1 The chamber used for this test shall have the following provisions:

a) An enclosure protected from air currents, but provided with means of venting fumes and admitting an adequate supply of fresh air at the bottom.

NOTE 1 — A metal box about 600 mm wide, 900 mm high and 600 mm deep, with a detachable front, a viewing window and suitable holes for intake of air and venting of fumes can be used.

NOTE 2 — Adequate safety precautions shall be taken to protect personnel from possible explosion of the components.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

b) A suitable stand or support for the resistors involving a minimum of heat transfer; and

c) A spirit burner of the pattern shown in Fig. 17 or of any other pattern. The fuel for the burner shall be good quality 66°O.P. industrial methylated spirit containing not more than 5 percent of wood naptha (*see* IS : 324-1959*). The burner and the flame are considered satisfactory if a bare copper wire 0·71 mm diameter having a free length of not less than 100 mm in the flame in the position to be occupied by resistors, melts in less than 6 seconds.

NOTE — The melting point of copper is 1 083°C.

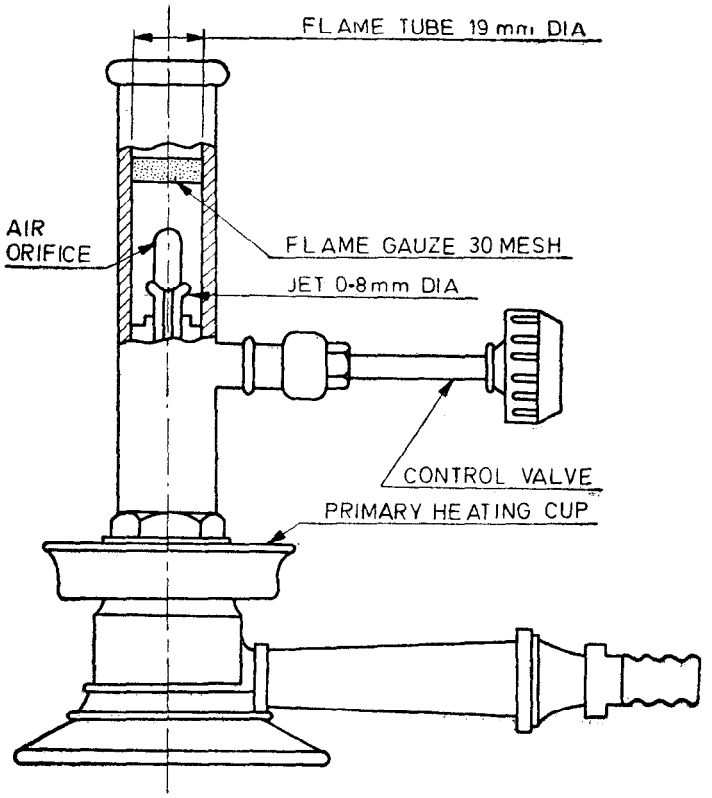


FIG. 17 SPIRIT BURNER

*Specification for ordinary denatured spirit (*revised*).

A-3. MOUNTING

A-3.1 The resistors shall be mounted on the stand placed within the test chamber, in such a manner, that they are not shielded from the flame by the support. The precise orientation of the resistors relative to the flame, if not stated in the relevant specification, shall be that judged to be the most unfavourable or which presents maximum surface to the test flame.

A-3.2 The height of the resistors shall be so adjusted that the lowest part of the resistors body is 51 mm from the top of the burner as shown in Fig. 18.

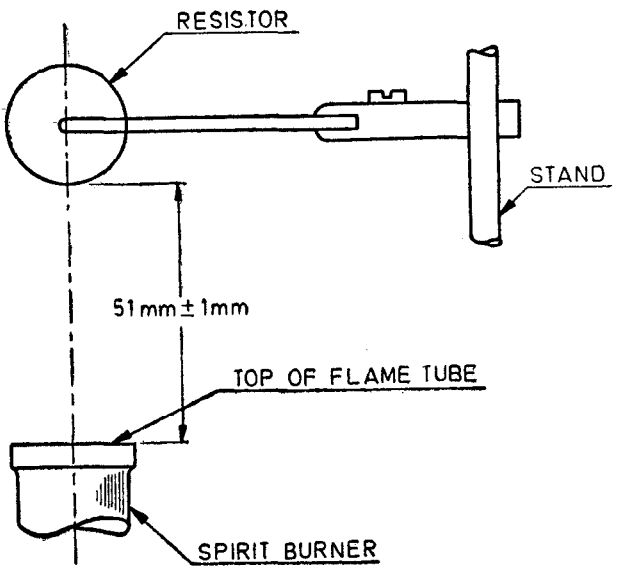


FIG. 18 RELATIVE POSITION OF BURNER AND RESISTOR

A-4. TESTING

A-4.1 After confirming that the flame is satisfactory as specified in **A-2.1** (c), the burner shall be placed underneath the resistors in such a manner that they are enveloped by the flame. The resistor shall be exposed to the flame for either one minute or any lesser time necessary to cause ignition.

A-4.2 If ignition has occurred, it shall not continue for more than 15 seconds or any other period specified in the relevant specification, after withdrawal of the flame.

A-4.3 No burning particle shall detach from the resistors.